DOCUMENT RESUME

ED 328 898 CS 010 427

AUTHOR MacRae-Campbell, Linda
TITLE The Importance of Neurological and Cognitive Research for Reading Instruction.
SPONS AGENCY Office of Educational Research and Improvement (ED), Washington, DC. Programs for the Improvement of Practice.
PUB DATE 89
NOTE 34p.; Commissioned by the OERI Literacy Project.
PUB TYPE Information Analyses (070) -- Reports - Evaluative/Feasibility (142)

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS *Brain Hemisphere Functions; *Cognitive Style; Elementary Education; *Individual Development; Lateral Dominance; Psychological Characteristics; Reading Improvement; *Reading Instruction; *Reading Processes; Reading Readiness; Reading Research; Teaching Methods
IDENTIFIERS *Brain Research; Triune Brain

ABSTRACT

New views of intelligence and cognitive learning styles highlight ways to increase educational effectiveness by improving instructional methods. Research shows that both hemispheres of the brain play a role in learning, but evidence indicates that one hemisphere may be more aroused than the other in the case of a particular child. Individuals with a leftward preference tend to perform better on face recognition tasks, while those with a rightward bias perform better on phonetic analysis. Instructional strategies should integrate processes performed by each hemisphere. Some researchers view the mind as triune, encompassing a primal mind, an emotional mind, and a rational mind. Because interesting and exciting instruction appeals to students, establishing an emotionally supportive environment helps facilitate learning. Research shows that the structures and abilities of the cerebral cortex are changed by enriching the environment. New neural connections are developed through: (1) positive social interactions; (2) new challenges; and (3) a healthy cardiovascular and pulmonary system. Furthermore, new research suggests that intelligence can be improved even despite multiple handicaps. Students have identifiable reading styles, so different instructional approaches may be appropriate for different children. Such diversity must be considered when reading programs are developed and implemented. (Fifty-eight notes are included; two addenda--on whole language and on technology and reading--are attached.) (SG)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

The Importance of Neurological and Cognitive Research for Reading Instruction

ED328898

CS010427

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

X This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

The Importance of Neurological and Cognitive Research for Reading Instruction

Written by Linda MacRae-Campbell, Director, New Horizons for Learning
For the Office of the Assistant Secretary

Neurological research of the last three decades has increased our knowledge of the functioning of the human brain. The plunge into the microscopic world of brain development and learning has yielded important indicators of brain growth and functioning, cognitive processing, hemispheric differences and integration, and vertical differences and integration. Knowledge of brain behavior is providing new tools for teachers and is impacting our educational programs. Recent research in the cognitive sciences also highlights ways to increase educational effectiveness. New views of intelligence and cognitive learning styles and modalities are impacting both instructional programs and educational methods. While we stand at the threshold of enhanced understanding, it is important to remember we are only at the threshold. New findings are emerging frequently and these will continue to mold our educational methods and systems as we endeavor to improve learning and teaching.

What has been learned to date from the neurosciences and cognitive sciences challenges many of the methods and programs currently in practice in our schools especially in the area of reading instruction. Historically, literacy instruction has been dominated by an analysis and learning of verbal codes. (1) During the last 20 years, phonics has been emphasized in many classrooms. In 1971, an extensive review of reading research and practice

nationwide revealed that phonics books and exercises were widely used. Since the early seventies, the use of phonics techniques has increased in both kindergarten and elementary classrooms. (2) During the early 1980's, John Goodlad studied more than 1000 classrooms including 129 elementary, 362 junior high, and 525 senior high classes and found that reading instruction stressed "the mechanics of word recognition, phonics, and vocabulary development." (3) Even though this analytical, skill-based method of reading instruction dominates our school reading programs, it does not help all students achieve literacy. The Department of Education estimates that there are 26 million adult illiterates in the United States and that minority youth have an illiteracy rate of 40%. (4) The growing body of neurological and cognitive research indicate ways that we may significantly reduce poor reading skills by varying the instructional strategies and programs offered to students. However, no universal panaceas have been or probably will be devised. The following survey of the neurological and cognitive implications for the improvement of reading instruction serve only as a beginning.

Hemispheric Implications for Reading Instruction:

The pioneering work of Joseph Bogen and psychologist Roger Sperry, who won the Nobel prize for his work in brain lateralization, made clear that we use different parts of the brain for different kinds of mental functions. While the left and right hemispheric research has become oversimplified in the popular press, it has served an important function by alerting us to the wealth of mental processes that can be tapped to enhance learning. New research is indicating that the earlier descriptions of hemispheric

specialization as a verbal/ visual dichotomy have been misleading and that language is processed by both hemispheres but in different ways. Neurosurgeon Bogen suggests that the difference between the two hemispheres is not so much content-specific, i.e. language in the left and spatial tasks in the right, as it is process-specific, resulting in the availability of two different conceptual styles. (5) The differing functions of these two conceptual styles are briefly summarized in the following description of Dr. Jane Healy, author of Your Child's Growing Mind:

"For most people, the right hemisphere learns by looking, and getting the whole intuitive "feel" of a situation, while the left tends to listen and analyze systematically. The right sees outlines and wholes, while the left arranges the details in order. The right is a simultaneous 'lumper', the left, a sequential 'splitter'." (6)

Both the left and right hemispheric processes are engaged in the complex task of reading as they are in nearly all learning experiences. Evidence strongly disputes the concept that students learn with only one side of the brain. However, there is evidence that individuals may have one hemisphere more aroused than another.(7) Jerre Levy, an associate professor of behavior sciences in the Department of Bio-psychology at the University of Chicago reports that people differ in the asymmetry of blood flow to the two sides of the brain. For example, individuals with an asymmetric flow to the right hemisphere perform best at perception completion tasks. Individual differences are also evident with people who demonstrate a biased preference for the right or left side. Individuals with a leftward preference tend to perform better on face recognition tasks and those with a rightward bias perform better on phonetic analysis. Levy stresses that different people will thus learn best with different methods of instruction. She states that

"the child with a biased arousal of the left hemisphere may gain reading skills more easily through a phonetic, analytic method while the child with a biased arousal of the right hemisphere may learn to read better by the sight method. I am suggesting only that the gateway into whole-brain learning may differ for different children, not that one hemisphere or the other should be the object of education. Ultimately, our aim should be to assure that the child who learns to read through phonics will develop a fluent skill in sight reading, and that one who learns through the whole word method will develop excellent skills at phonetic analysis so that any new word can be decoded." (8)

Richard Sinatra, the Director of Reading, in the School of Education at St. John's University in Jamaica, New York, further outlines specific right and left hemispheric processes to achieve literacy. Like Levy, Sinatra advocates a balanced approach to reading instruction by suggesting a variety of processes to tap the "conceptual styles" and strengths. His chart is included below.

Contribution of Each Brain Hemisphere to Reading and Writing (9)

Left Hemisphere Verbal Mediation	*Right Hemisphere* Nonverbal Mediation
• Phonemic discrimination; grapheme to phoneme correspondence; analytic processing of parts to name word	• Grapheme array perceived in gestalt; deriving meaning directly from spoken or printed word; image produced
• Learning rules of syllabification and identification of word parts (structural analysis) such as prefixes and suffixes; applying rules to lists of words	• Learning new words holistically, in "natural" content areas such as music, gym, shop, the arts, and some sciences; associating real experience with word meaning
• Memorizing words of songs such as with the "Star Spangled Banner"	• Feeling memory of melody patterns through chanting, jingling, and singing to induce words
• Using nonsense syllables and nonsense words to teach word attack skills	• Teaching concrete, image producing words and building associative webs (synonym, antonym, classification) amongst word meanings
• Naming and describing objects and parts of space through verbal mode	• Finding way in space; tracing route, touching and holding objects to label and describe; arousing associations with object
• Identifying and naming words using denotative meanings such as dictionary definitions	• Identifying and naming words using connotative, associative, image producing strategies through figures of speech, metaphor, simile, and analogy; using the context to arrive at an intelligent guess of a word's meaning
• Sequencing events or numbering in order; arranging from part to whole	• Relating events to a whole theme; associating ideas to central image which may or may not have sequence orientation
• Locating the main idea sentence in a paragraph and constructing an outline of parts	• Forming key image of a paragraph (or theme) and visualizing details in relationship to central image
• Reading and following verbal directions	• Looking at a plan, blueprint, map, or picture; tracing route, internally verbalizing, and then reading or writing directions
• Reading and writing exercises which emphasize denotative language and literal comprehension such as getting the facts, "locating the answer," etc.	• Obtaining meaning from the visual (pictorial), and structural (webs and semantic maps); personalized, affective associations (emotion) made with theme and ideas in passage
• Subskill approach to reading and writing development such as occurs in skills management systems, criterion reference systems, diagnostic-prescriptive programs, etc.	• Whole discourse mode or whole language approach; presenting schema or nonverbal representation of whole discourse scope, such as semantic mapping; arousing personalized association to theme
• Attention to mechanics of writing, i.e., spelling, punctuation, and agreement	• Attention to the gestalt of writing coherent sentences in meaningful sequences
• Analyzing and labeling parts of speech, finding subjects and predicates, telling functional use of sentence parts	• Composing and writing sentences through intermediary steps such as sentence combining or through whole composition involvement in prewriting (composing), writing, editing, and refining.
• Analyzing literary works, separating parts and passages to isolate content or intent of author	• Literary synthesizing by discovering relationship between two or more disparate themes, events, characters, etc.
• Writing compositions from lists of facts and information given on a topic; constructing outlines following teacher prearranged format	• Writing from visual compositions, which are sequences of pictures arranged to *infer* a story or stories
• Writing answers to specific questions or topics where information is generally given in text and needs to be located and copied; summarizing a work; adding to existing information	• Synthesizing several works or passages to relate meaning in a novel way; creating new ideas not there before

Both hemispheres of the brain have their role to play in the reading process. Literacy demands both analysis and synthesis. As Jerre Levy points out, a child's skill to read and appreciate literature includes the "ability to synthesize letters into words, words into sentences, sentences into meaning and thought. It depends on the ability to apprehend and respond to the rhythm of language; to imagine and to feel the scenes and moods; to empathize with the characters and understand their emotions, values and personalities; and to integrate all this into a rich and full meaning with structure, configuration and detail. Such a process cannot be accomplished by either side of the brain alone, but represents so intimate an integrative activity that, in the end, we cannot say which side of the brain contributed what." (10) Sinatra advocates that our reading instructional strategies demonstrate this degree of integration as well. He proposes that holistic, visual, musical, thematic, whole language approaches be used in addition to the analytic, sequencing processes found in most reading programs. Additional information on the whole language method as an example of one integrated approach to the teaching of reading is found in Addendum #1.

The Triune Brain Theory:

In addition to the right and left hemispheric research, another model of the brain has been proposed by Dr. Paul MacLean, chief of the Laboratory of Brain Evolution and Behavior of the National Institute of Mental Health. According to MacLean, the human brain consists of three distinct brains that have evolved throughout time signifying "a triune intelligence comprised of

a primal mind, an emotional mind, and a rational mind." (11) MacLean theorizes that the human brain records our evolutionary past and impacts much of our contemporary behavior. At the base of the brain, in the basal ganglia (R-complex), is "the reptilian brain", a direct legacy from primitive reptilian species. The reptilian brain is responsible for instinctual behaviors that include establishing territory, forming social groups and determining hierarchies. As creatures evolved from reptile to mammals, the limbic system, also termed the "mammalian brain" was next added onto our neurological structure. (12) The mammalian brain is located on top of the R-complex and regulates human emotion. This brain, shared with primitive mammals, instills the desire to nurture our young, to flee when threatened and to play. (13) The five major glands included in the limbic system, the thalamus, hypothalamus, hippocampus, amygdala and pituitary, are responsible for motivation, attention, and retention. The limbic system is the gateway to the neocortex, the third level of the brain.(14) The neocortex, the newest evolutionary addition, contains the two hemispheres of the brain and is the location of mental faculties such as abstraction, visioning, planning, selecting and creating. (15)

The triune brain theory gives us insight into human behavior through an understanding of the components of "triune intelligence". A critical aspect of MacLean's research centers on the limbic system. It appears that the brain operates with an emotional bias system. Information that is perceived by the learner as helpful, interesting, and/or rewarding is eventually processed by the brain. Cognitive functioning is determined by the emotional state of the learner. (16) In short, we learn what we want to learn.

Dr. Beverly Galyean in a paper presented to the State Department of Education in California explains, "To begin the process of thinking, "both intra and extrasomatic stimuli travel up the polysynaptic fibres of the spine and pass through the five limbic censors before entering the neocortical region. If the limbic glands do not allow passage, the stimuli are never encoded, never stored, never remembered and consequently, never learned. (17) Galyean further explains that ...." whenever the individual experiences an abundance of fear, anxiety, confusion, fatigue, boredom or non-relevance when faced with certain stimuli (experiences, situations, information, material) the thalamus, charged with the expectation of displeasure, secretes endorphins to prevent the incoming information from ever being processed.....Our brain's chemistry, controlled by inner images of pleasure or displeasure, simply will not allow us to learn any material that appears negative. On the other hand, when the images associated with learning are positive, promising pleasure, reward and/or novelty, other chemicals are secreted that hasten the entry of new stimuli to the cortical region. Learning becomes easy - naturall" (18)

Other researchers in addition to MacLean, acknowledge the importance of emotional factors and learning. Fred Newmann, the Director of the National Center on Effective Secondary Schools, states that educators can motivate students to achieve if they fulfill students' needs for competence, extrinsic rewards, intrinsic interest, social support, and sense of ownership. These factors engage students in learning as well as activate motivation or create motivation. (19) Dr. Csikszentmihalyi, the Chairperson of the University of Chicago's Department of Behavioral Sciences, notes that enjoyment enhances learning, that optimal learning occurs when a person wants to learn for his

or her own reasons and when the rewards are for the satisfaction of oneself and not others. (20) In researching optimal learning, motivation and student emotional responses, Csikszentmihalyi noted that students felt anxious when they perceived they lacked the skills to successfully meet a challenge and bored when their skills superseded the challenge. He states, "Schools must become more exciting for learning. If they don't, we'll waste a valuable resource: children's minds." (21)

Dr. Csikszentmihalyi also has studied the qualities noted in learning activities that students and adults enjoy pursuing. These qualities are termed the "flow experience" and include:

*opportunities for action in which there's a close match between personal capabilities and challenge
*clear goals and immediate feedback
*merging of action and awareness
*concentration on relevant stimuli and exclusion of worries
* sense of control
*absence of the feeling of self-consciousness
*distorted sense of time, usually briefer
*intrinsic motivation (22)

Csikszentmihalyi notes that though these characteristics are common to motivated learners, they are not frequently present in schools. An example of a technology - oriented reading program that attempts to include these components is briefly described in Addendum #2.

Another important affective component in school life is the psychological environment. Establishing an emotionally supportive environment helps facilitate student learning. Dr. Healy, author of Your Child's Growing Mind, notes that "...encouraging a child to express feelings and make choices, causes

all learning to stick better. Some educators believe that schools' neglect of these needs may account for many problems in motivation." (23) Leslie Hart explains that "when the individual detects threat in an immediate situation, full use of the new cerebral brain is suspended, and faster acting simpler brain resources take larger roles..... Cerebral learning and threat conflict directly and completely." (24) Reading psychologist and researcher Frank Smith addresses how threat and anxiety impact a student who is learning to read, "No one who is afraid of the consequences of reading will be able to read, and no one who is afraid of failing to read will learn to read- one reason why a sure way to give children a reading problem is to tell them they have one." (25) One of the ways that students know they have a reading problem is their removal from the regular classroom for a pull-out program. According to Robert Slavin at Johns Hopkins University, pull-out programs do not increase student achievement, while providing instruction that is poorly regulated with students' regular classroom instruction, and that negatively label students. (26) Students need an emotionally supportive environment to learn in, where their self-images are enhanced and threat and anxiety are reduced or eliminated.

There are a myriad of implications for reading instruction and reading programs from the triune brain theory and similarly oriented research. They are as follows:

* The classroom environment should be emotionally supportive, consistent and responsive to the individual student.

* Reading materials and methods that are intrinsically interesting, personalized, helpful, relevant, pleasurable, playful, and/or novel should be used.

* Reading materials or methods that induce fear, anxiety, confusion, boredom or seem non-relevant should be replaced.

* Students should experience some freedom of choice in their reading activities, methods and books.

* Students should remain in their regular classrooms for reading instruction.

* Reading programs should match student skills with an appropriate level of challenge, have clearly communicated goals, provide immediate feedback, give students a sense of control and a lack of self-consciousness.

The Neurological Impact of the Learning Environment:

Dr. Marian Diamond, a neuroanantomist at the University of California, Berkely, has done extensive research on the impact of the environment and learning. Her work demonstrates that the structure and abilities of the cerebral cortex are changed by enriching the environment. (27) The conditions which foster the development of new neural connections include:

1) positive and nurturing social interaction (28)
2) new challenges and materials to work with (Diamond does warn against over-stimulation, however.) (29)
3) and a healthy cardiovascular and pulmonary system. (30)

In a series of experiments, enriching sensory environments created physiological changes in the neurological structure of the subjects in as little as four days. Increases in brain weight, thickness of the cortex, development of more glial cells and dendrites as well as stronger synapses are some of the

observable differences Diamond has noted in her research. (31) Such changes in the human brain enable faster and more complex thinking patterns. After studying tissue samples of Einstein's brain, Diamond noted more glial cells than in the average human brain and theorizes that this may be due to his vigorous cognitive demands. (32)

Diamond affirms the plasticity of the human brain, noting that it can be changed throughout life. While the growth of the brain is greatest during early childhood, its structures and abilities can be enhanced at any age. Changes in the cerebral cortex also affect the limbic system, improving learning and emotional behaviors such as creativity, self-love and love for others. (33) Diamond states, "The environment can play a role in shaping brain structure and learning. This is important to consider in shaping learning environments in any setting for learners of all ages." (34)

The educational environment can enhance the learning experience. When applied to the area of literacy instruction, the following may prove to benefit student learning:

* positive teacher/ student interaction
* positive student/ student interaction
* periodic introduction of new challenges, materials and methods of instruction
* adequate physical exercise or kinesthetic instructional activities
* rich sensory experiences incorporated in the physical setting and student activities

Neurological Development throughout Life:

Laying the foundation for proper neurological and intellectual development is a process that begins before conception. The physical conditions, mental and emotional attitudes and environments of future parents will greatly influence new generations. Though learning to read usually takes place during the school years, much can be done to enhance neurological development prenatally, during infancy and early childhood as well as throughout all of life. This enhancement, not to be confused with overstimulation and the superbaby syndrome, refers to establishing solid foundations for the natural unfoldment of skills and talents. It is beyond the scope of this paper to survey a lifespan approach to literacy, however the following topics suggest a starting point for prenatal, infant and early childhood years:

* prenatal influences such as health, nutrition, emotional and physical environments, personal, professional and community resources, hereditary factors, etc.

* parent/ child bonding

* the five senses as the foundation of human intelligence

* parents as first teachers

* developmental timetables

* learning environments at home and elsewhere

* neurologically-enhancing play and challenges

*daycare, pre-schools, Headstart programs, etc.

To truly improve reading instruction for school-aged children, a systemic approach to enhancing cognitive development, beginning pre-natally and onward, is necessary. Solid foundations can be created so that students may more readily benefit from reading instruction during their school-aged years. Literacy is also a skill that continues to develop throughout one's life. Reading programs during the K-12 grades can communicate to students that reading is one skill that, with exercise, will continue to develop and strenghten throughout their lifespan.

The Importance of Research from the Cognitive Sciences for Reading Instruction

A wealth of recent research in the cognitive sciences has demonstrated ways to improve learning at all ages and at all ability levels. New defintions of human intelligence have emerged, etching expanded images of what it means to be human. Learning projects with those once thought to be uneducable bear witness to our unlimited potential and researchers working in the field of learning styles underscore our individual uniqueness while providing us with concrete tools to improve learning and tap inherent strengths. There are many implications for improving reading instruction by incorporating what has been learned in the cognitive sciences.

New Views of Human Intelligence:

Neuropyschologist Dr. Howard Gardner of Harvard University has identified seven human intelligences that he has named linguistic, musical, logical/mathematical, spatial, bodily/kinesthetic, interpersonal and intrapersonal intelligences. Each intelligence is independent and requires its own nurturing and development. (35) Unfortunately, most school systems teach, test, reinforce and reward linguistic and logical/mathematical intelligences. While these skills are essential in a literate, information society, many individuals have talents in the other five intelligences which often go unacknowledged. Throughout his book, Frames of Mind: The Theory of Multiple Intelligences, Gardner discusses the cultural relativity of the concept of intelligence and notes outstanding examples of each intelligence in countries around the world. He further states that students should be exposed to classroom activities rich in all seven intelligences so that their inherent strengths can be observed, nurtured and engaged in the learning process. The multi-faceted view of human intelligence that the Theory of Multiple Intelligences proposes gives educators the possibility of both curricular enhancement and an array of teaching strategies used to teach any one topic. Gardner states, "Even if we all study the same thing, we don't have to learn it in the same way." (36) Subject matter in any content area can be taught linguistically, mathematically/logically, musically, kinesthetically, visually and with interpersonal and intrapersonal approaches as well. Teaching and learning through the multiple intelligences may reach many poorly achieving students who do not learn in traditional ways.

Two other well-known psychologists have also developed new definitions of intelligence. Dr Robert Sternberg of Yale University identifies three kinds of intelligence which include the traditional view of intelligence, an insightful, adaptive component and a "street smarts" form of intelligence. (37) Dr. David Perkins at Harvard suggests three basic aspects of intelligence as well. These include a neurological and experiential component, strategies and problem solving processes, and content, factual kinds of learned information. (38)

The research of these and other psychologists is redefining human intelligence as well as suggesting new approaches to developing such intelligence. Such theories propose innovations in the teaching and learning process that include diverse instructional strategies incorporating the arts, higher order thinking skills and problem-solving processes, real life application of skills, the sensory modalities, and individual as well as collaborative learning opportunities. These implications certainly apply to the teaching of reading and all other content areas.

Learning at All Ability Levels:

Reuven Feuerstein, an Isreali cognitive psychologist, rejects a closed and fixed concept of intelligence and proposes that intelligence is an open, dynamic system capable of enhancement at any age and at any ability level. Dr Feuerstein has developed a Theory of Cognitive Modifiability which states that intelligence can be modified and improved despite single or multiple handicaps. (39) Over 600 studies research around the world are currently being conducted with a diversity of groups that include the severely retarded to the gifted, the very young to the very old, indigenous people to corporate officers. (40) Feuerstein has created an assessment device that

indicates what type of intervention and how much intervention is needed to enhance the cognitive system. He has also created learning instruments that develop higher mental processes which often subsequently lead to increases in minimum competencies.

One study conducted with over 200 Isreali adolescents, with IQ's between 55 to 90, yielded dramatic results in student achievement after a two year period of time. Even though the control group received 300 more hours of curricular instruction than the experimental group, the experimental group's performance on achievement tests equalled or surpassed that of the control group. (41) In a study in New York City, 200 students who qualified for remediation and worked with Feuerstein's program, gained 2.2 to 8.0 normal curve equivalents in reading and mathematics after two years. (42) Feuerstein's program of modifying higher level thinking skills and subsequent academic achievement may offer remediation approaches for a wide variety of learners.

Dr. Renee Fuller, another cognitive psychologist, has achieved dramatic results with reading and literacy, often with individuals whose IQ's are as low as 20! Fuller explains "Quite by accident, my altering of the teaching of reading made me stumble on teaching techniques that made sense to the human brain." (43) The components of Fuller's reading system, entitled, Ball-Stick-Bird include rearranging the teaching of the alphabet sequence. After two initial letters are taught, word formation begins. After the fourth letter of the alphabet is taught, words comprised of these four letters are used in a story. The student begins reading by beginning with a story and focusing upon comprehension. Fuller explains other components of her

reading system, "To reduce the initial memory load, and therefore speed up story reading, (1) only capital letters are used at first; (2) the letters are called by their most usual sound; (3) the student is shown how he or she can build the letters with just three forms. The forms are a circle (called a ball), a line (called a stick), and an angle (called a bird). Also to speed up contextual reading, the layout of the books is in thought packages, or easy to read phrases." (44) Phonics skills are taught by having leaners become "word detectives".

Fuller's reading method, now used in more than 3000 classrooms or schools, seems to diminish the occurrence of dyslexia or learning disabilities. Fuller feels that this is due to emphasis upon the use of story, the incorporation of the four sensory modalities into the reading process and the unique sequencing of the information taught in her books. Repeated tests with learners who have severe brain conditions and IQ's as low as 20 - 50 have demonstrated their ability to learn to read and to comprehend. (45)

The work of Reuven Feuerstein and Renee Fuller highlight that all people at all ability levels can be taught. To work with diverse population groups to achieve literacy will require new teaching strategies. These require that the learner be an active participant in the reading process, the inclusion of sensory stimulation, the incorporation of higher level thinking skills and the sequencing of programs to allow for student success.

Reading Styles and the Improvement of Reading Instruction:

Much recent research has been done to identify individual differences in learning styles. Learning styles are information perceiving and processing traits that characterize how individuals learn best. Acknowledgement of individual differences in learning once again underscores the issue that some of our instructional approaches are inappropriate and inadequate for many individuals. Not all students will experience success when taught in the same way. A diversity of learning styles emphasizes the necessity for a diversity of learning opportunities.

Matching Student Learning Styles for Reading:

The term reading style refers to an individual's learning style when engaged in the process of reading or learning to read. A decade of reading styles research indicates that students do have identifiable reading styles. When students' learning styles are matched for reading, significantly higher achievement in reading fluency and comprehension results across grade levels. Dr. Marie Carbo, the leading national specialist and researcher of reading styles emphatically states that the current emphasis on low-level reading skills such as phonics drills and worksheets are counterproductive for many students and poor readers. (46) Research also indicates that neither the phonic nor the whole word reading method match the reading styles of many children. Most primary children and poor readers are global/ kinesthetic/ tactile learners who need to learn to read with holistic methods. Some of these approaches include: identifying student reading style strengths and interests, using varied instructional stategies that include

tape-recorded books, story writing, role play, hands-on reading materials such as typewriters, computers, sand trays, paints, etc. and providing students with high interest reading materials.(47) The research on reading styles does suggest that some children do benefit from phonics instruction. There is also indication that some youngsters who learn phonics do not need such instruction to be able to read and others who are unable to master phonics can learn to read with other approaches. (48) Student approaches to reading are individual and unique. This diversity needs to be taken into account when reading programs are developed and implemented.

Conclusion: The Implications of Neurological and Cognitive Research for Reading Instruction

A survey of the neurological and cognitive sciences research of the last two decades reveals strong implications for the improvement of reading instruction. These implications fall into three broad categories: the learning environment, the teaching methods and programs used in reading instruction and special programs for literacy development.

The Learning Environment and Reading Instruction:

Both the psychological as well as the physical learning environment influence a learner's ability to learn to read. To help students succeed, classroom or other learning environments should include:

a rich, sensory environment

a psychologically "safe" environment where student self-image is maintained, risk-taking is encouraged and emotional support is consistent

positive interaction between student and teacher and student and classmates

reading instruction is provided in the normal classroom and not in pull-out models as much as possible

physical exercise or kinesthetic learning opportunities are provided for optimum neurological and physical functioning.

Instructional Strategies and Reading Program Components:

Research suggests that to significantly reduce poor reading skills the instructional strategies and reading programs will necessarily need to offer a richer variety of options for more students to succeed. Phonics, basal readers and skills-based reading programs will effectively teach some students, but it appears that the majority will need the following approaches:

Varied instructional strategies that include:

teaching to different student learning styles
sensory learning experiences
application of skills to real life situations
incorporation of the arts into instruction
affective association with reading materials
individual as well as collaborative instruction
setting clear goals and providing immediate feedback
incorporating student choice into some reading activities
problem-solving strategies
higher order thinking skills
the multiple human intelligences

Reading program components:

whole word and whole language approach
materials that are intrinsically interesting, personalized, relevant, pleasurable and novel
students maintain some sense of control
individualization of challenges
collaborative learning opportunities
emphasis upon meaning and comprehension
consideration of lifespan learning factors in the creation and implementation of reading programs
incorporation of the above instructional strategies

Special Programs that Deserve Consideration in Teaching Reading:

Since many of the traditional approaches to the teaching of reading are not successful with a wide variety of students, some innovative programs may be worthy of consideration:

whole language approaches
computer assisted instruction approaches
Instrumental Enrichment programs of Dr. Reuven Feuerstein
Ball-Stick-Bird reading series
Reading Styles Reading Program of Dr. Marie Carbo
maintenance of phonics and basal reader programs for use only with those students who can benefit from them
other reading programs that incorporate a whole-to-part approach such as through the use of story, the senses, the arts, etc.

A variety of approaches to reading instruction is what is required to enable a variety of students to learn to read. After reviewing hundreds of reading method studies, Reginald Corder stated,

> "Underlying all the methods is an implicit hope that a panacea will be found. This, too, is a historic characteristic of reading methods in the United States. There is a strong belief that if only we are scientific and careful enough and thorough enough we will find the one method that will work with all children. In reality, all methods that we have investigated failed to teach some children to read." (49)

Reading instruction in the United States will need to be diverse in its approach if it is to succeed at insuring literacy for its richly diverse population.

Addendum #1:

Whole Language: One Example of a Hemispherically Integrated Approach to Literacy

Whole language programs blend reading, writing and speaking instruction and reject the skills-based approach of most basal reader programs. Whole language methods integrate quality literature, story writing and the arts and phonics when needed. Learning to read is approached with the intention of first deriving meaning from the printed text. Students then gradually fill in the parts, learning to recognize words and grasping the correspondences between letters and sounds. Proponents of whole language state that it is a whole-to-part instructional process as opposed to the part-to-whole approach of most basal readers. This holistic approach claims that students learn to read through meaning rather than mechanically acquired skills. (50)

Whole language instruction is gaining in popularity. New Zealand, the country that ranks first in literacy out of the 159 members of the United Nations, teaches reading with whole language. (51). Nationally, 85% of the kindergarten teachers in Vermont report that whole langauge is the prevailing philosophy in their classrooms. The California State Board of Education has recently approved the use of language arts textbooks that minimize the skills-driven approach of basal readers in favor of high quality literature. (52)

In a study of 18,126 students, the Portland Public School District reported higher reading achievement after one year of a whole language approach program. The students' achievement scores were compared with reading achievement during the five previous years when basal series were used. The results showed significantly higher achievement for all ethnic groups including Native Americans, Asians, blacks, Hispanics and whites. (53) The whole language reading method will probably continue to gain in popularity thus challenging the traditional, more technological model of reading instruction. It offers one integrated approach to the teaching of reading by incorporating the strengths of both hemispheric processes of learning.

Addendum #2:

Technology and Reading:

Some Computer Assisted Instructional programs used in reading programs meet many of the qualities identified by Dr. Csikszentmihalyi in "flow experience" or optimal learning situations. These qualities include: matching a student's capabilities with an appropriate challenge level, clear goals and immediate feedback, concentration on relevant stimuli and exclusion of worries, student maintains a sense of control, and lacks self-consciousness.

Computer Assisted Instruction systems are computer programs that tutor and adjust the level of difficulty of problems while the student is working. The program will automatically drop to an easier level if the student misses several consecutive exercises of one type. It also automatically advances if the student gets several consecutive questions of one type correct. New problems are created by choosing numbers at random eliminating the possibility that a student will repeatedly encounter the same problem. The program also uses supportive comments, gives "award ribbons" and keeps mistakes nonpublic.

CAI systems have been used in 100's of districts throughout the United States with success. (54) Two districts that .provide examples of the effectiveness of Computer Assisted Instruction include Calvert County, Maryland and Parish, Loiusiana. The Louisiana site focuses on high school at-risk students. After a total of 14.2 hours of computer reading instruction during eight weeks, the students had gained 1.2 grade equivalents.(55) Students' remarks about the program reveal their enjoyment: "The machine doesn't know I'm black." "It doesn't hate me." "It gives me a second chance." "I can do it!" (56)

In Calvert County, Maryland, students begin CAI as a routine part of their schooling with a resultant 82% of the students scoring above the national norm, and nearly 11% scoring in the ninth stanine in reading. Superintendent Eugene Karol further explains the benefits of CAI instruction by noting that the average 8th grader is performing in language arts at the 12th grade level, reads at the 11th grade level while having an average IQ of 107. He states that "It's ordinary kids doing extraordinary work." (57)

The best evaluated and most consistently effective CAI models are Computer Curriculum Corporation's drill and practice programs. Currently, CAI programs are very expensive so there is some question about their cost effectiveness at this point in time. However, as software programs improve in quality and hardware becomes less expensive, computers can play an important role in remedial reading and language programs. (58) Used as a preventative measure as it is in Maryland, CAI may continue to prove to be an important tool in advancing literacy.

References

(1) Richard Sinatra, "Learning Literacy in Non-Verbal Style" in Student Learning Styles and Brain Behavior, National Association of Secondary School Principals, Reston, VA. 1982, p. 203.

(2) Marie Carbo, "Debunking the Great Phonics Myth", Phi Delta Kappan, November, 1988, p. 226.

(3) John Goodlad, "What Some Schools and Classrooms Teach", Educational Leadership, April, 1983, p.13.

(4) Marie Carbo, "Increasing Reading Achievement", Streamlined Seminar, National Association of Elementary School Principals, Alexandria, VA. Aug., 1987. p.1

(5) Gabriele Lusser Rico and Mary Francis Claggett, Balancing the Hemispheres: Brain Research and the Teaching of Writing, University of California, Berkeley, Bay Area Writing Project, 1980, pp. 6-7.

(6) Jane M. Healy, Your Child's Growing Mind, Garden City, New York: Doubleday, 1987, p.115.

(7) Jerre Levy, "Children Think with Whole Brains: Myth and Reality" in Student Learning Styles and Brain Behavior, National Association of Secondary School Principals, Reston, VA.,1982, p. 181.

(8) Ibid. p. 176.

(9) Richard Sinatra, "Learning Literacy in Nonverbal Style", in Student Learning Styles and Brain Behavior, National Association of Secondary School Principals, Reston, VA., 1982, pp. 208-209.

(10) Jerre Levy, "Children Think with Whole Brains", in Student Learning Styles and Brain Behavior, National Association of Secondary School Principals, Reston, VA., 1982, p.176.

(11) Paul MacLean, "A Meeting of the Minds", Dromenon: A Journal of New Ways of Being, Fall/Winter, 1980, p.12.

(12) Ibid. pp.13-16.

(13) Ibid. pp. 15-19.

(14) Beverly Galyean, "The Brain, Intelligence, and Education: Implications for Gifted Programs" a paper presented to the California State Department of Education, Division of Gifted and Talented, January, 1981. p. 5.

(15) Ibid. p.5.

(16) Ibid. p.4.

(17) Ibid. p.6.

(18) Ibid. p.6.

(19) Fred Newmann, "Student Engagement and High School Reform", Educational Leadership, Feb. 1989, p.34.

(20) Mihalyi Csikszentmihalyi, "Enjoyment Enhances Learning" in Lifespan Learning on Centerstage of the Future, Seattle: New Horizons for Learning, 1989, p.7.

(21) Ibid. p.8

(22) Ibid. p.8

(23) Jane Healy, Your Child's Growing Mind, Garden City, New York: Doubleday, 1987, p. 16.

(24) Leslie Hart, Human Brain and Human Learning, New York: Longman, 1983, pp.108-110.

(25) Frank Smith, Reading Without Nonsense, New York: Teachers College Press, Columbia University, 1978, pp. 48-49.

(26) Robert Slavin & Nancy Madden, "What Works for Students at Risk: A Research Synthesis", Educational Leadership, Feb. 1989, pp. 4-5.

(27) Marian Diamond, "Stimuli Alters the Brain", in Lifespan Learning on Centerstage of the Future by Jean Wiley Hyler, Seattle: New Horizons for Learning, 1989, p. 4.

(28) Ibid.

(29) Jane Healy, Your Child's Growing Mind, New York: Doubleday, 1987, p. 299.

(30) Dee Dickinson, "New Horizons" in Transforming Education in In Context, No. 18 Winter, 1988, p.7.

(31) Jane Healy, Your Child's growing Mind, New York: Doubleday, 1987, p. 299.

(32) Ibid. p. 300.

(33) Marian Diamond, "Stimuli Alters the Brain", in Lifespna Learning on Centerstage of the Future by Jean Wylie Huyler, Seattle: New Horizons for Learning, 1989, p. 4.

(34) Ibid.

(35) Howard Gardner, Frames of Mind: The Theory of Multiple Intelligences, New York: Basic Books, 1983, pp. 60-68.

(36) Howard Gardner, from a presentation at the The Lifespan Learning Conference hosted by New Horizons for Learning in Fairfax, VA., 1988.

(37) Robert Sternberg, Beyond IQ: a Triarchic Theory of Human Intelligence, New York: Cambridge University Press, 1985.

(38) David Perkins, Knowledge as Design, New Jersey: Eribaum Association, 1986.

(39) Reuven Feuerstein, Instrumental Enrichment: An Intervention Program for Cognitive Modifiability, Baltimore, Maryland: University Park Press, 1983.

(40) Dee Dickinson, "New Horizons" in Transforming Education issue of In Context, No. 18, Winter, p.8.

(41) Reuven Feuerstein, Instumental Enrichment: An Intervention Program for Cognitive Modifiability, Baltimore, Maryland: University Park Press, 1983, p. 369-370.

(42) Francis Link, "Instrumental Enrichment: A Strategy for Cognitive and Academic Improvement", in Essays on the Intellect by Francis Link, editor, Alexandria, VA.: Association for Supervision and Curriculum Development, 1985, pp. 101-103.

(43) Renee Fuller, "Beyond IQ", in Transforming Education in In Context Winter, 1988, No. 18, p. 13

(44) Ibid. p.12

(45) Renee Fuller, "Dyslexia Vanishes When Brain-Based Reading Method is Used" in Cutting Edge, No. 17, Sept. 1987.

(46) Marie Carbo, "The Evidence Supporting Reading Styles: A Response to Stahl", Phi Delta Kappan, December, 1988, p. 323.

(47) Streamlined Seminar, National Association of Elementary School Principals, "Increasing Reading Achievement", August, 1987.

(48) Marie Carbo, "The Evidence Supporting Reading Styles: A Response to Stahl", Phi Delta Kappan, December, 1988, p. 326.

(49) Reginald Corder, An Information Base of Reading: A Critical Review of the Information Base for Current Assumptions Regarding the Status of Instruction and Reading Achievement in the United States. Berkeley, CA.: Educational Testing Service, Berkeley Office, U.S. Office of Education Project 0-9031, ERIC ED 054 933, (1971) p.107.

(50) Constance Weaver, "Reading as a Whole: Why Basal Reading Series are Not the Answer", Holistic Education Review, Fall, 1988, pp. 8-11.

(51) Marie Carbo, "Debunking the Great Phonics Myth", Phi Delta Kappan, November, 1988, p.226.

(52) Association for Supervision and Curriculum Development, Update, "Whole Language: New View of Literacy Gains in Influence", January, 1989, pp.1, 6-7.

(53) "Report to the Board of Education and to the Community on Progress toward Improving Student Achievement as Measured by Districtwide Basic Skills Test Scores." Portland, Oregon Public Schools, 1988.

(54) Beatrice Gross, "Can Computer-Assisted Instruction Solve the Dropout Problem?", Educational Leadership, February, 1989, p. 51.

(55) Ibid., p. 50.

(56) Ibid., p. 51.

(57) Ibid., p. 51

(58) Ibid. p. 51